Model Calculations of Non-Symmetric SLS Sextupole

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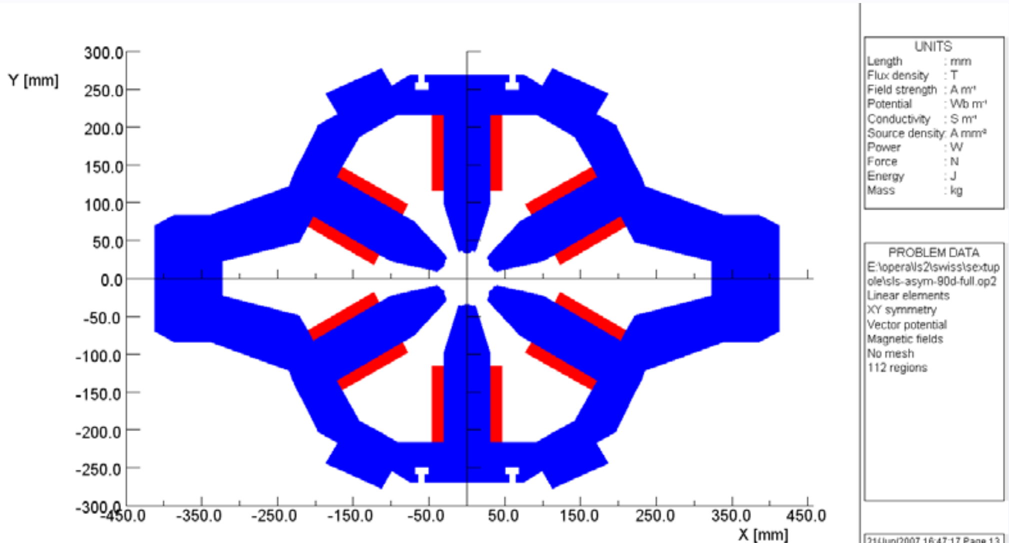
Model Calculations

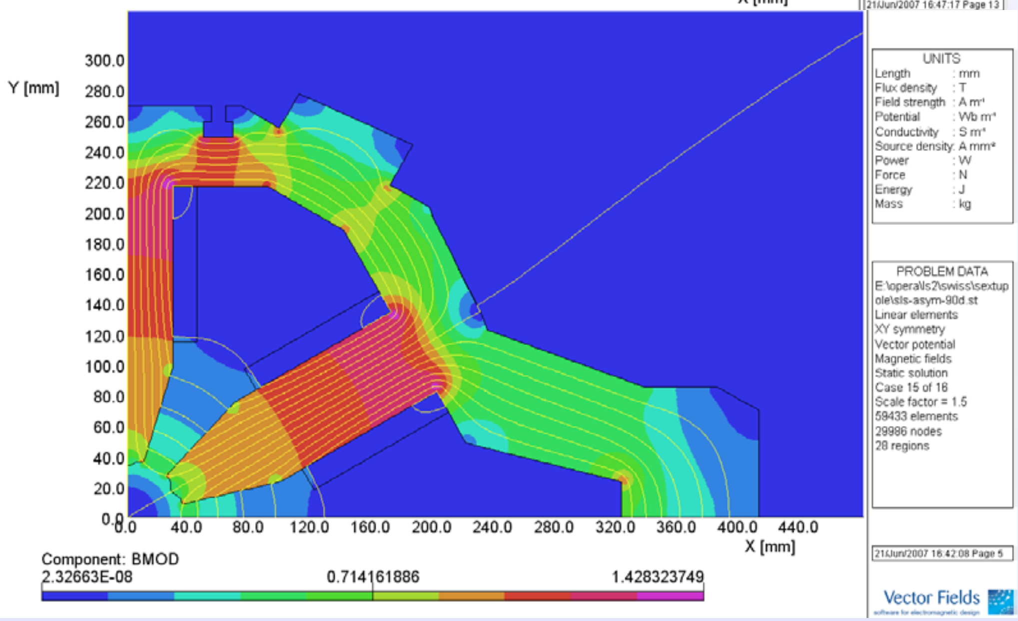
These calculations are based on the information available

Expect differences between the calculations and measurements from

- Differences between the drawings available and the drawings/sketches based on which the laminations for magnet were cut by the vendor
- Actual laminations Vs. drawings (i.e. inspection report on laminations, etc.)
- Shimming, chamfering and other corrections in a particular magnet
    - We are told it was done after measurements – a right thing to do, and that's what we would do, but it could cause a large difference between calculation and measurements
- Inherent errors in measurements and calculations (2-d calculations are generally more accurate because of number of mesh points and complexities, but if the magnet is short 3-d would be more representative)

Allowed and Non-allowed Harmonics





This sextupole does not have the ideal 12-fold symmetry/asymmetry

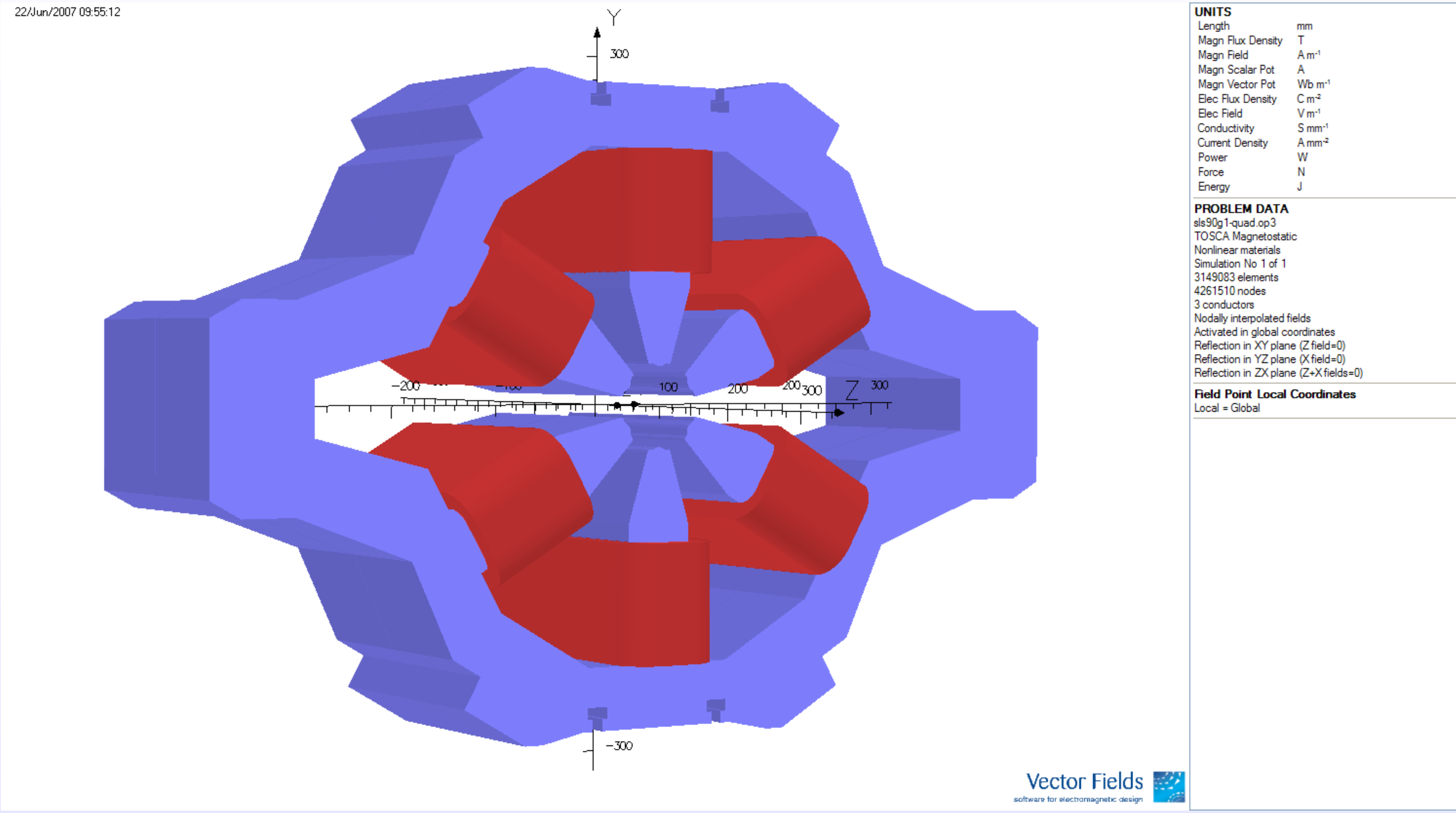
The coil still has the right symmetry (except for the small end effects);

but the iron has only 4-fold symmetry (dipole type rather than sextupole type).

Therefore, in addition to b9, b15, b21, also expect b1, b3, b7, b11,…

All other harmonics (e.g. all skew terms) are either due to construction errors or measurement errors

3-d Model



Several variants of this model were made to study the influence of chamfering (end)

BNL Measurements (integral) at 25 mm ~100 A, up ramp

n	an	bn
1	-11.21	-35.88
2	-1.36	-1.64
3	-0.10	10000
4	-1.01	-0.65
5	0.97	-4.63
6	-0.48	0.45
7	-0.57	0.99
8	-0.09	0.05
9	0.14	-2.01
10	0.01	0.14
11	-0.02	0.15
12	-0.09	0.10
13	-0.12	-0.04
14	-0.18	-0.18

In addition to b9, b15, b21, also expect b1, b3, b7, b11,… due to broken symmetry.

All other harmonics (e.g. all skew terms) are either due to construction errors or measurement errors.

This sextupole does not have the ideal 12-fold symmetry/asymmetry

The coil still has the right symmetry (except for the small end effects);

but the iron has only 4-fold symmetry (dipole type rather than sextupole type).

3-d Model Results at 100 A

Symmetry (and some lack of it) will allow the following normal harmonics:

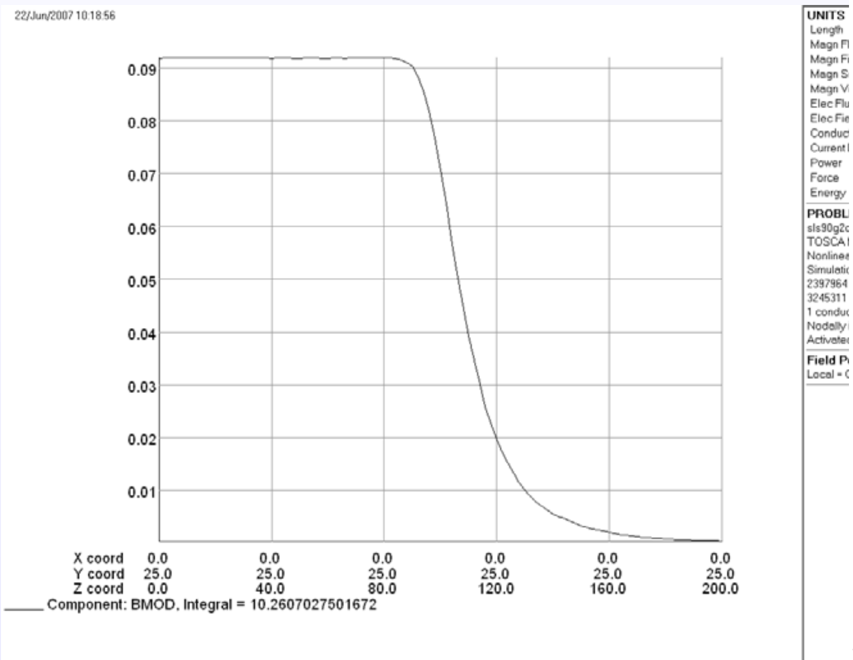
n	1	5	7	9	11	13	15	17	19	21	23	25	27
No chamfer	-109.12	-17.55	4.90	10.26	1.40	-0.54	8.41	0.08	-0.09	3.46	-0.07	0.05	0.24
Chamfer 10	-103.89	-16.27	4.36	3.00	1.15	-0.43	7.12	0.15	-0.07	3.32	-0.07	0.05	0.23
Chamfer A	-107.93	-17.01	4.58	-0.70	1.32	-0.51	7.50	0.08	-0.09	-3.33	-0.07	0.04	0.23
Chamfer D25	-103.94	-16.81	4.80	2.70	1.37	-0.71	7.74	0.23	0.01	-3.40	-0.04	0.03	0.16
Chamfer best guess	-106.50	-16.91	4.63	-3.67	1.28	-0.48	7.76	0.12	-0.08	-3.39	-0.07	0.05	0.23
2-d harmonics	-57.02	-13.44	6.09	-4.05	1.76	-0.54	8.01	0.21	0.03	-3.53	-0.08	0.04	0.24
Measured	-35.88	-4.50	1.00	-2.02	0.21	-0.06	6.89						

Given all the uncertainties, the measurements and calculations are closer than what I would have expected.

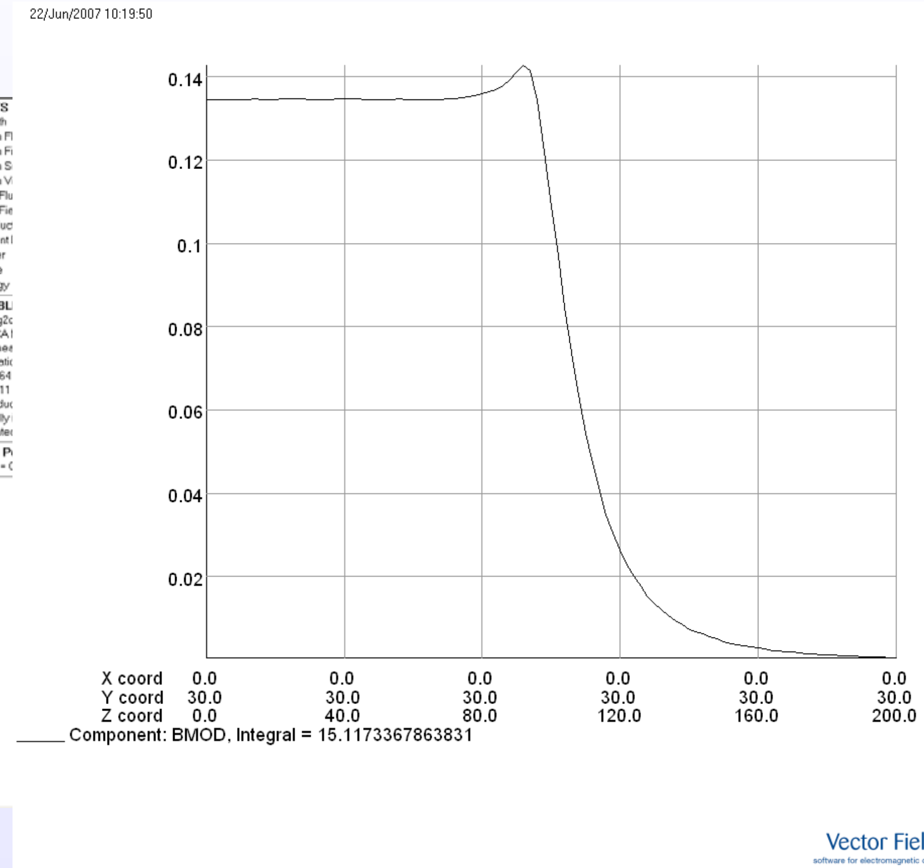
3-d model do not include leads and any other 3-d material

- For allowed terms (b9, b15, b21, etc.), 3-d models are more reliable in short magnets because of importance of end geometry.
- For semi-allowed terms (b1, b5, b7, b11, b13, b17, etc., 2-d models are more reliable because of better meshing, etc.

Field Profile



Magnitude of Field at Y=25 mm



Magnitude of Field at Y=30 mm

(Influence of end can be seen)

Variation in chamfering showed significant variation in field